Automated Demand Response: a Grid Resource for Integration of Renewables

IEPR Workshop

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Lawrence Berkeley National Laboratory

Demand Response Research Center

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Traditional Ancillary Services & AutoDR

1. Traditional A/S methods:

- **Thermal generation plants use fossil fuels, & high cost.**
- **Grid-scale storage is environmental friendly, but cost is high ($1500 - $4000 / kW)**

2. Potential Advantages of AutoDR systems:

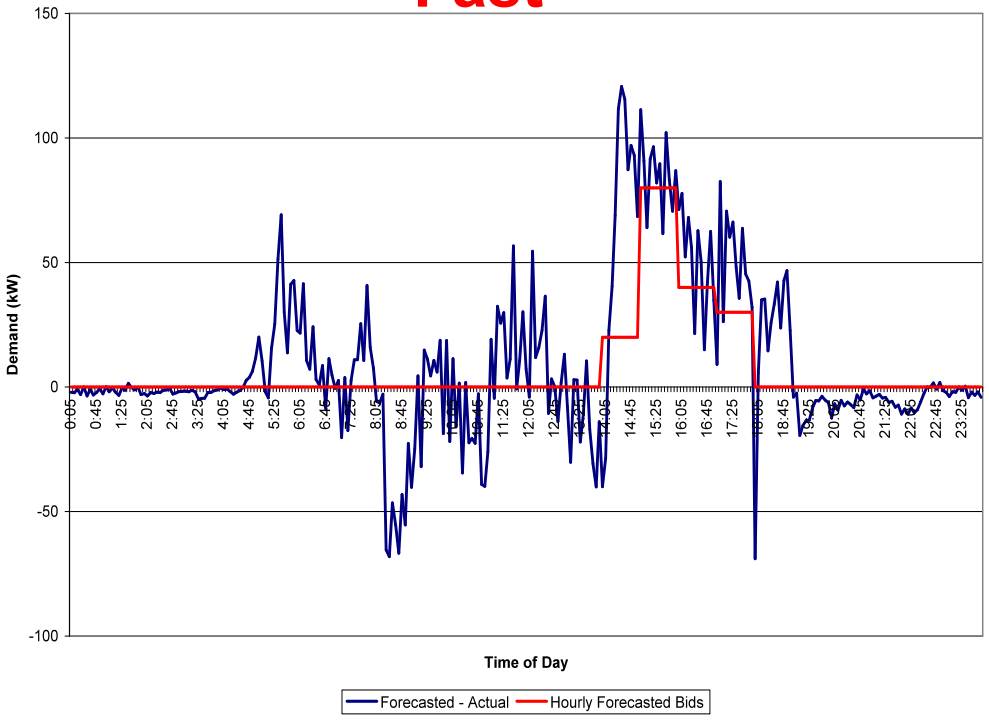
- **Lower first cost ($75 - $300 / kW) for current programs**
- **Lower operating costs**
- **Lower carbon footprint**
- **Leverages multi-purpose systems for energy efficiency**

AutoDR: Proven Results

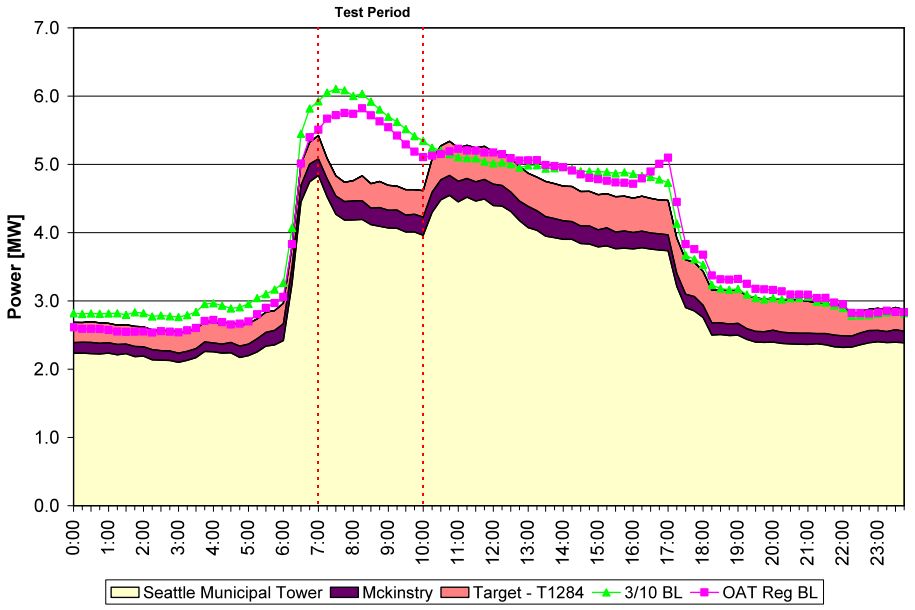
AutoDR Research & Commercialized Deployments have proven:

- **Multi-year performance during Peak Periods (~100 MW existing capacity)**
- **Fast response: < 5 min. (Participating Load Pilot)**
- **Cold winter mornings: 7:00 AM – 10 AM (Pacific Northwest Pilots)**

Fast



Early & Cold



Challenges for AutoDR as Ancillary Services

1. **Economic incentive structure unclear**
2. **Resource varies based on time, temperature**
   - Few data about off-peak DR
3. **AS requirements may increase cost of AutoDR**
   - Monitoring, verification, telemetry
   - Dedicated network connections
4. **Portfolio management**
   - Load shaping
   - Geographic issues (Sub-LAP)

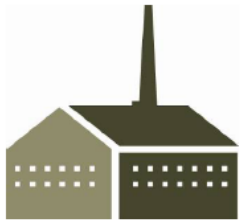
CAISO Programs and AutoDR

Examples of Needs for AutoDR

-Shift Load to Night
-Daily Peak Management
-Ramp Smoothing

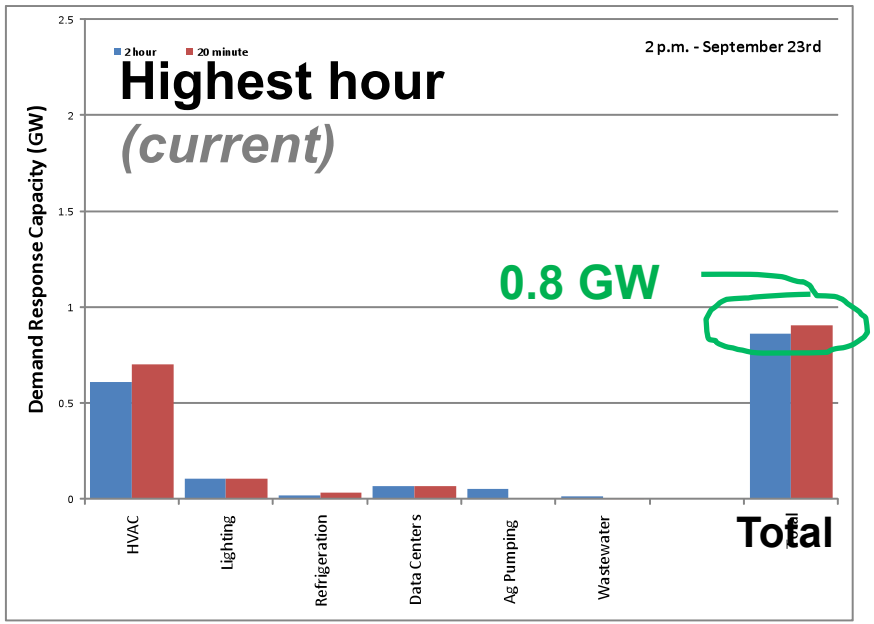
AutoDR for Existing CAISO products	Service	Response Time	Duration
AutoDR	Reg Up	Start <1 min. Reach bid <10 min	15 - 60 min
AutoDR	Reg Down	Start <1 min. Reach bid <10 min	15 - 60 min
AutoDR	Non-Spin	< 10 min	30 min
Future	Spin	~ Instant Start Full Output <10 min	30 min

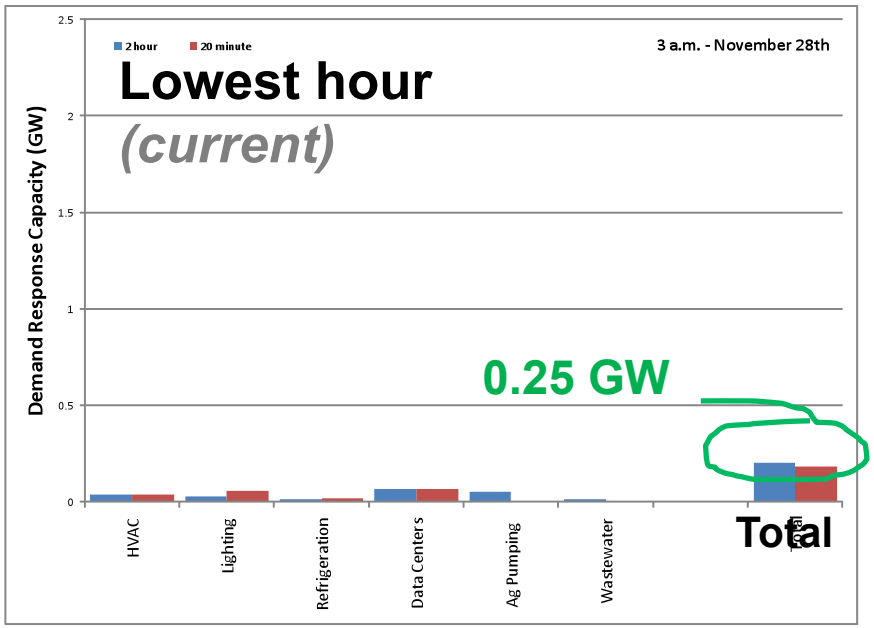
End Uses & Response

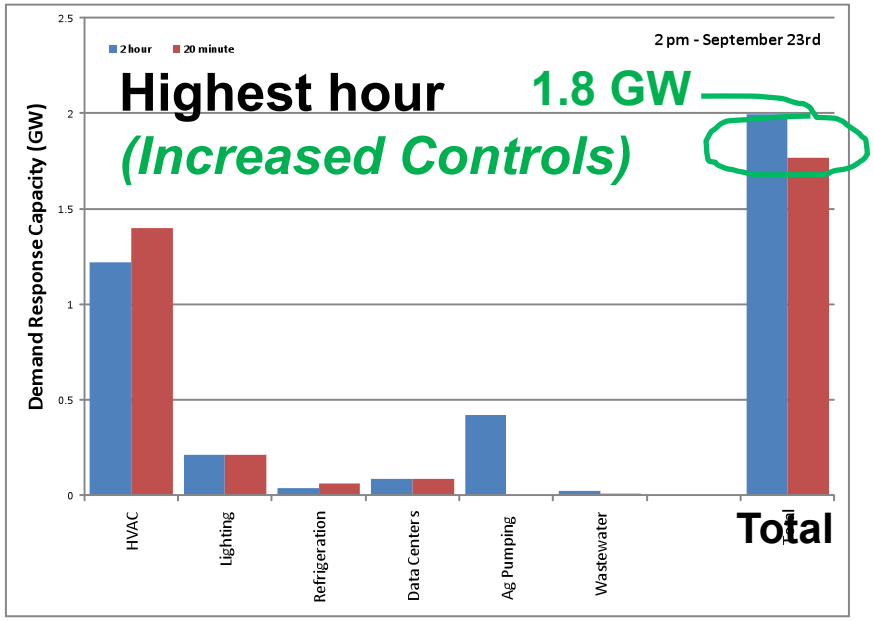


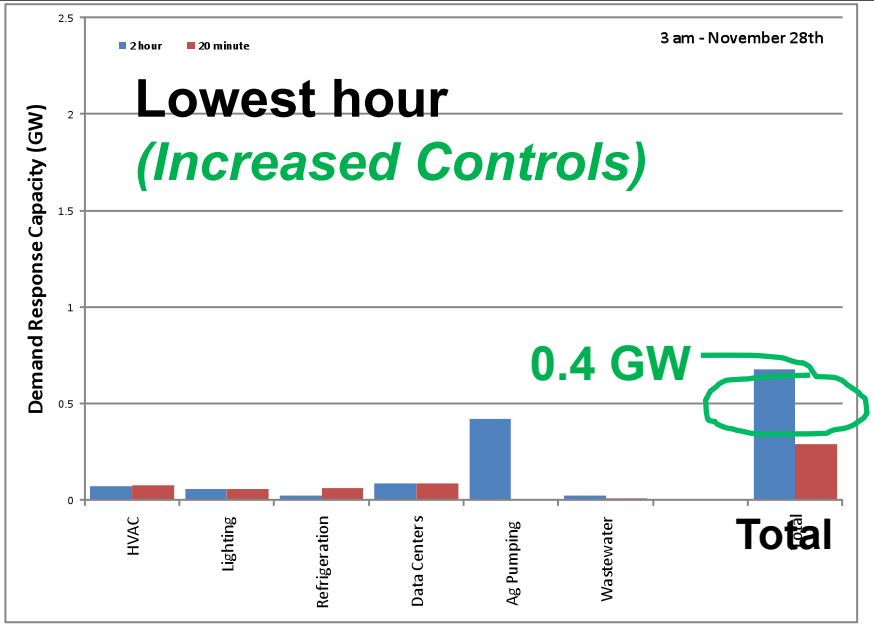
End Use	Type	Modulate	On/Off	Max. Response Time
HVAC	Chiller Systems	Setpoint Adj.		15 min.
	Package Unit	Setpoint Adj.	Disable Compressors	5 min.
Lighting	Dimmable	Reduce Level		5 min.
	On/Off		Bi-Level Off	5 min.
Refrig/Frozen Warehouse		Setpoint Adj.		15 min.
Data Centers		Setpoint Adj., Reduce CPU Processing		15 min.
Ag. Pumping			Turn Off selected pumps	5 min.
Wastewater			Turn Off selected pumps	5 min.

Shed Estimates: Highest & Lowest hours of the Year



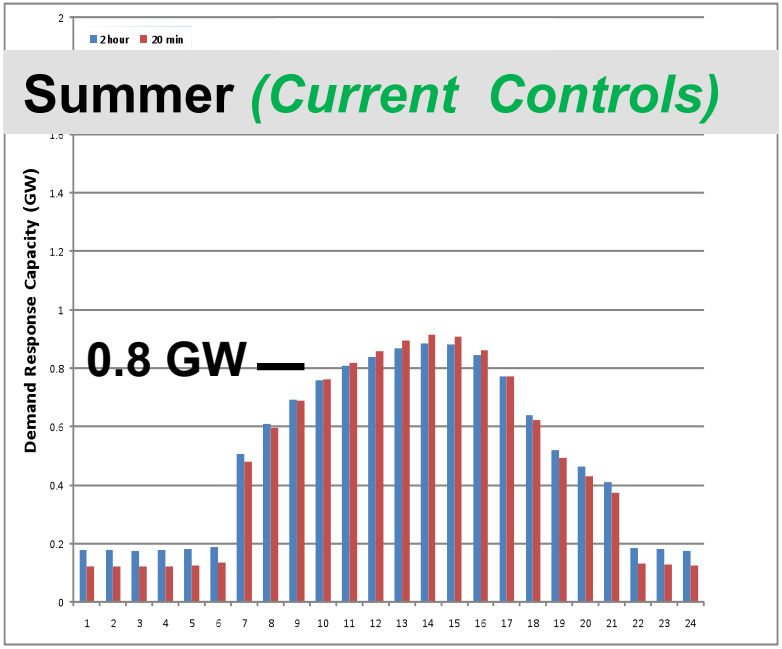




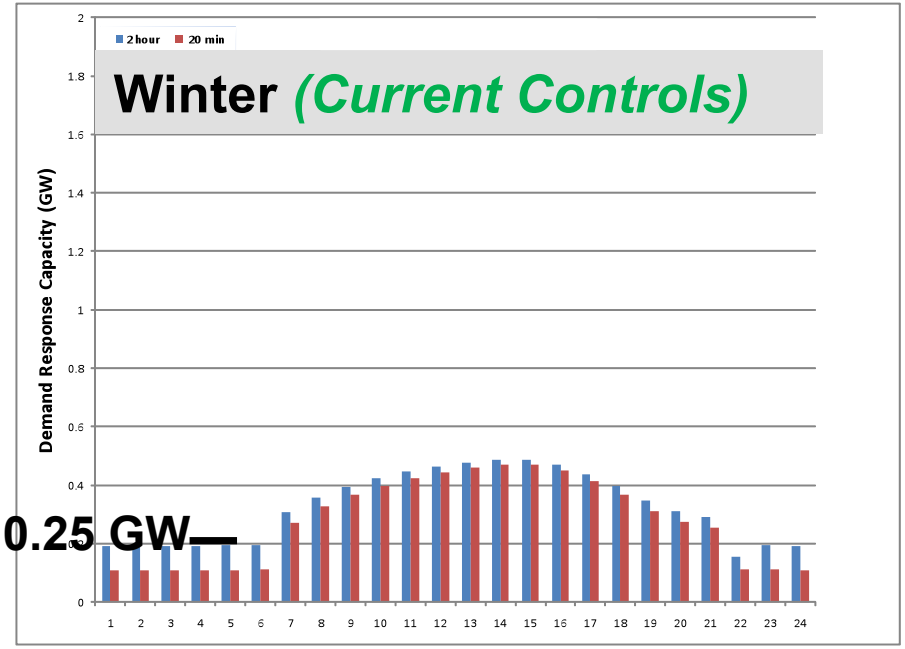


Shed Estimates: Summer & Winter 24 hr. Profiles

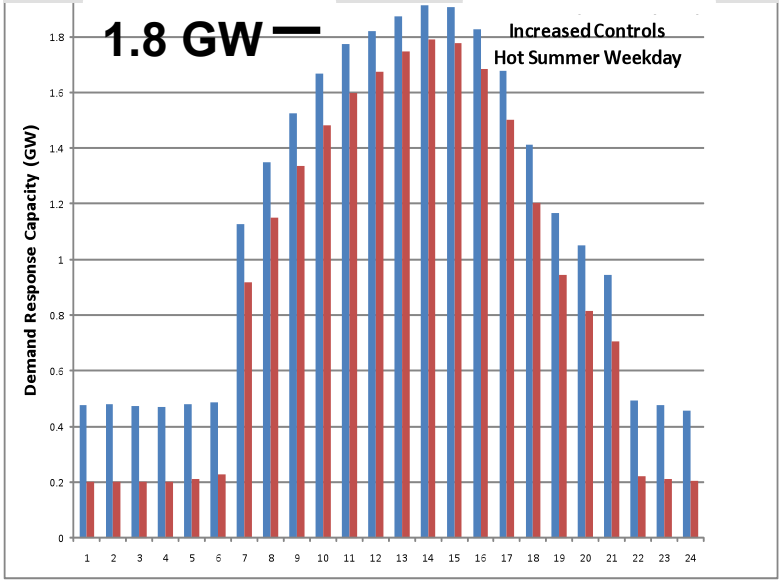
Summer *(Current Controls)*



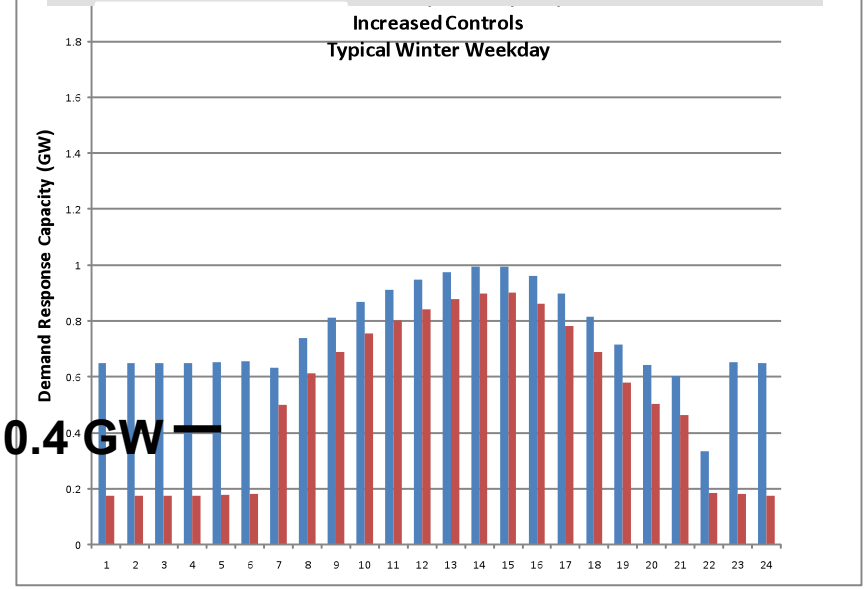
Winter *(Current Controls)*



Summer *(Increased Controls)*



Winter *(Increased Controls)*



Conclusions & Future Research

Conclusions

Preliminary estimate: AutoDR could provide 0.25 to 0.8 GW of AutoDR ancillary services in the existing stock throughout CA

Investments to improve controls that are currently "unreachable" to AutoDR could double the shed potential to 0.4 to 1.8 GW

Future research

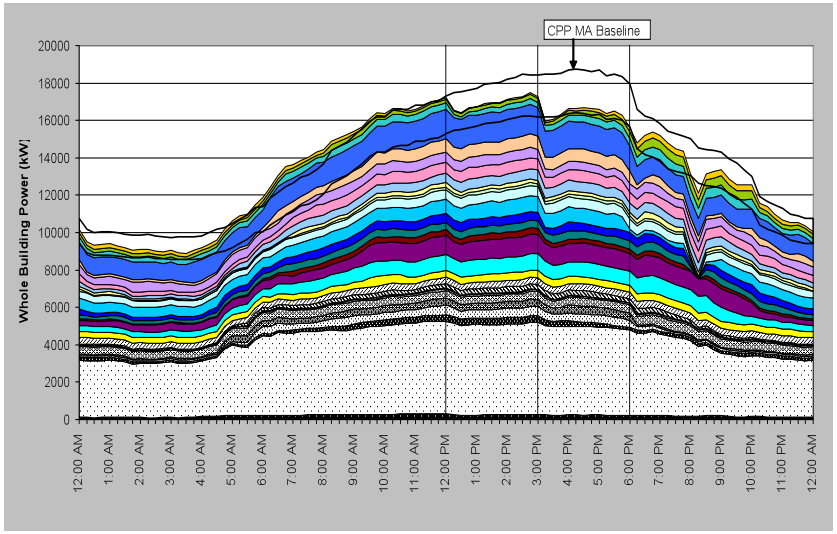
- **Economic evaluation**
- **Additional off-peak data from field tests & surveys**
- **Geographic considerations**
- **More sheddable loads 24/7/365**

Backup slide -Background & Goals

Background

- **California Renewable Portfolio Standards increasing to 33% by 2020**
- **Wind & Solar resources are variable and intermittent**
- **Grid requires over 4 GW of ancillary service to maintain grid stability**
- **Automated Demand Response pilots demonstrated ancillary services**

Goal of Scoping Study – Develop preliminary estimate and feasibility of capacity of AutoDR in California as a resource for renewables integration.

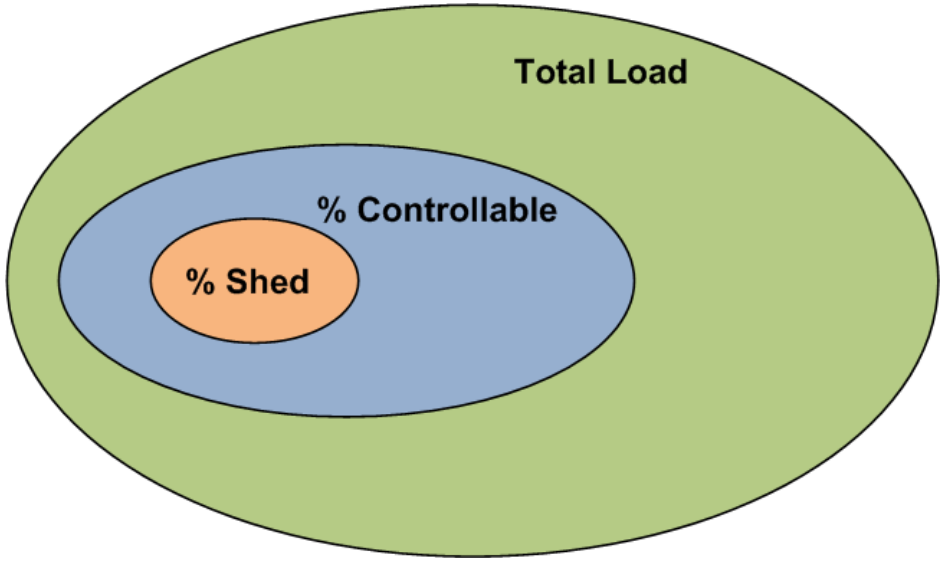


Backup slide - Methodology for Resource Analysis

1. Determine total electric load profiles for commercial and industrial sectors & key end-uses

2. Determine % of loads that could be controlled using current site infrastructure, and AutoDR technology

3. Determine % shed for each controllable load



Estimated Shed = (Load) x (%Controllable) x (%Shed)

Backup slide - Methodology Assumptions

1. Statewide load data, field test results & engineering judgment used to estimate potential

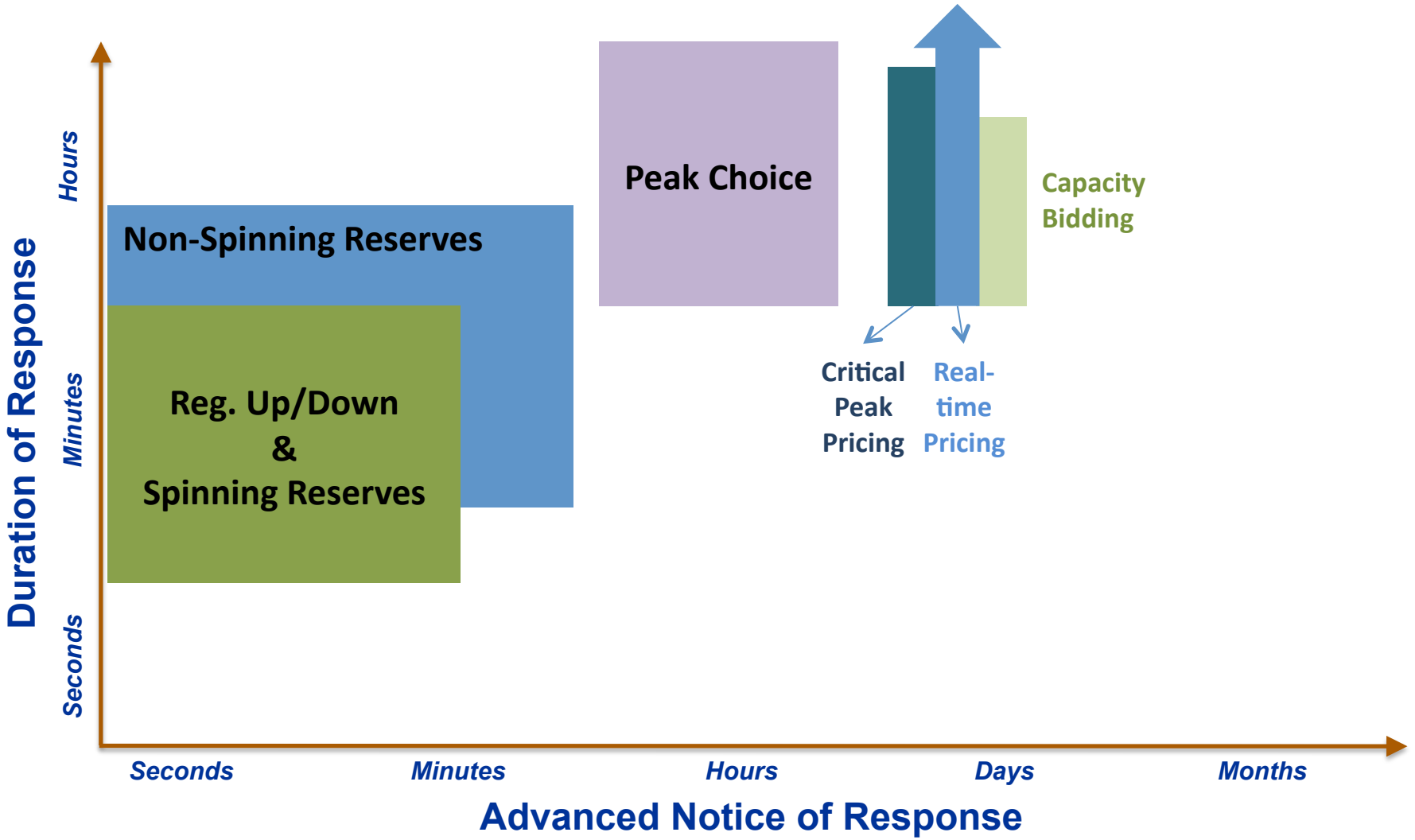
2. Multipliers selected based on existing or planned CAISO products for renewables integration

Duration	Ramp time
2 hour	15 min.
20 min.	5 min.

3. Commercial building type and end-uses evaluated

4. Industrial load shapes evaluated based on case studies and scoping studies

Backup slide - Demand Response Opportunities: Advance Notice and Duration of Response



Backup slide - AutoDR Terminology & Link to Batteries

Shed	Energy reduced during specified period (e.g., reduced lighting) - net energy reduction
Shift	Energy moved to different time period- minimal change in consumption
Charge	Energy use to store load (e.g., pre-cool or charge batteries)
Discharge	Energy storage supplies local loads (thermal or electrical) or provides power to grid